Exhaust gas heat exchanger in an internal combustion engine

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Also published as:
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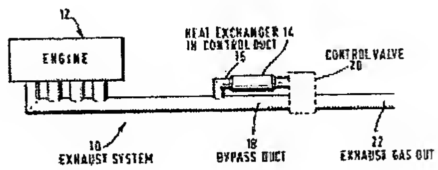
Abstract of **GB 2301177 (A)**

A method of controlling the flow of exhaust gasses in an internal combustion engine in order to allow the engine to be warmed up more quickly in which a heat exchanger 14 is provided in a control duct 16 of the engine exhaust system and a bypass duct 18 is provided through which exhaust gasses can flow without passing through the heat exchanger. The method comprises progressively closing, via control valve 20, at least partially the bypass duct 18 to divert at least a proportion of the exhaust gasses through the heat exchanger 14 in the control duct 16 thereby causing the engine coolant to extract heat from the heat exchanger.

FIG. 1



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INT CL[6] F01N 5/00 5/02, F01P 3/00 11/00 11/20, F28F 27/02
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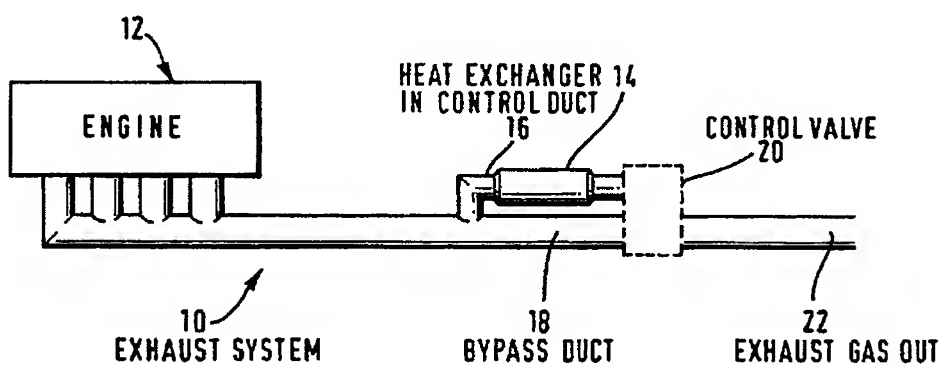
(54) Exhaust gas heat exchanger in an internal combustion engine

(57) A method of controlling the flow of exhaust gasses in an internal combustion engine in order to allow the engine to be warmed up more quickly in which a heat exchanger 14 is provided in a control duct 16 of the engine exhaust system and a bypass duct 18 is provided through which exhaust gasses can flow without passing through the heat exchanger. The method comprises progressively closing, via control valve 20, at least partially the bypass duct 18 to divert at least a proportion of the exhaust gasses through the heat exchanger 14 in the control duct 16 thereby causing the engine coolant to extract heat from the heat exchanger.

FIG. 1



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

GB 2 301 177 A

FIG. 1

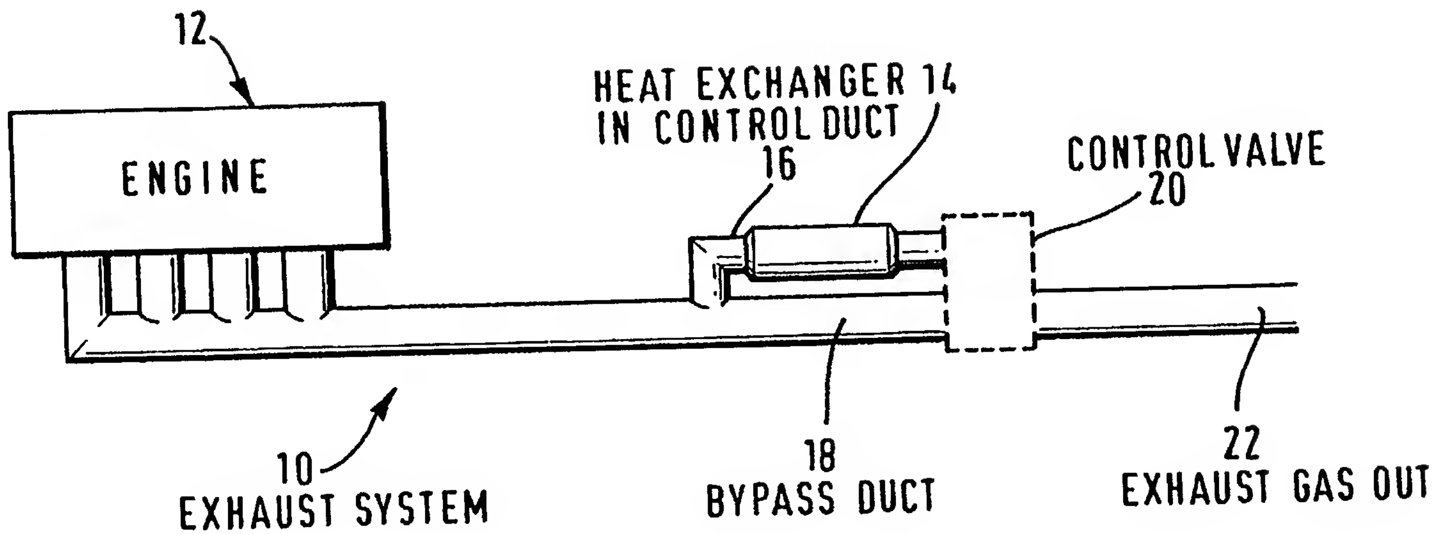

12
ENGINE
HEAT EXCHANGER 14
IN CONTROL DUCT
16
CONTROL VALVE
20
10
EXHAUST SYSTEM
18
BYPASS DUCT
22
EXHAUST GAS OUT

FIG. 2

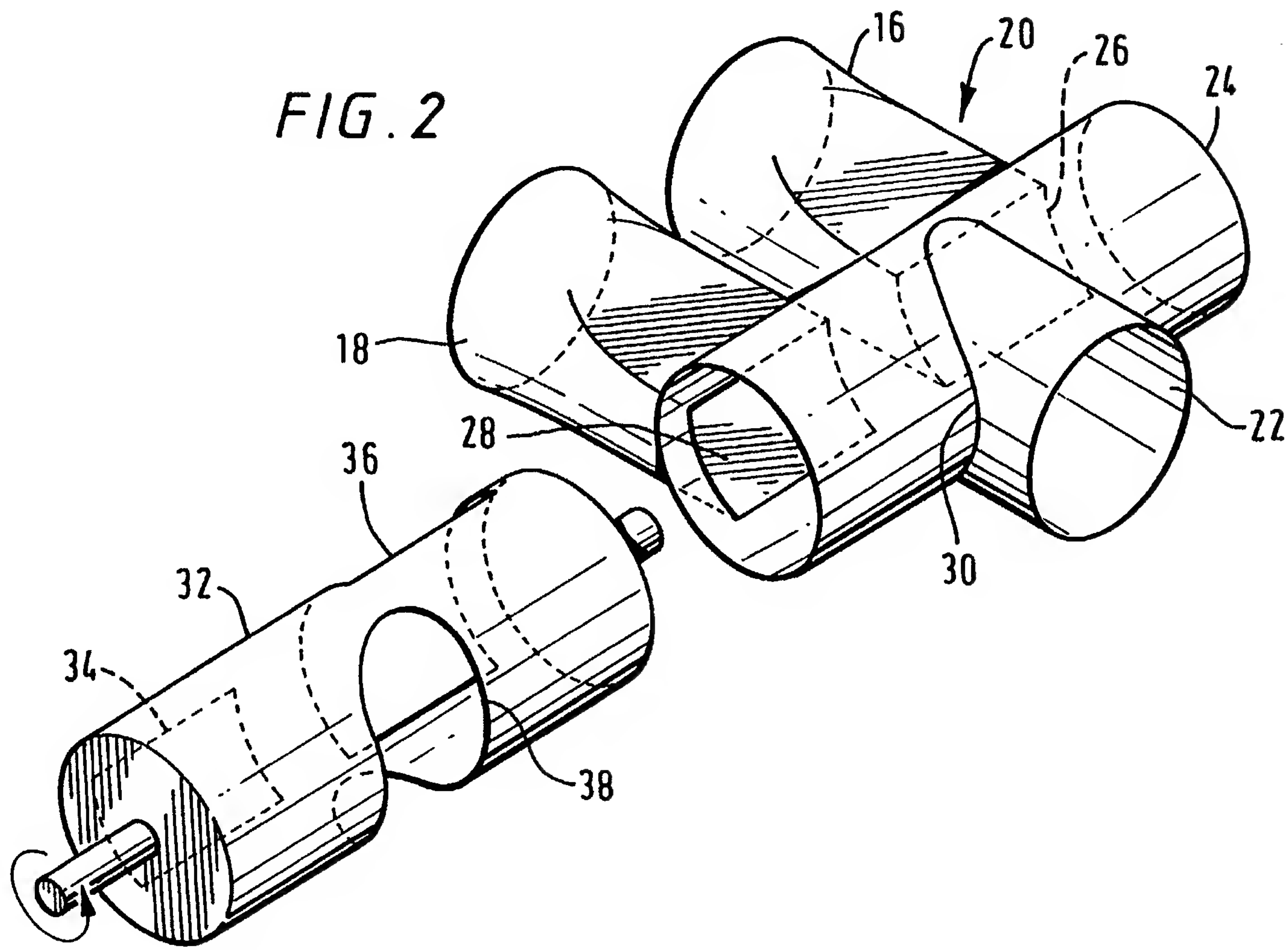


FIG. 3

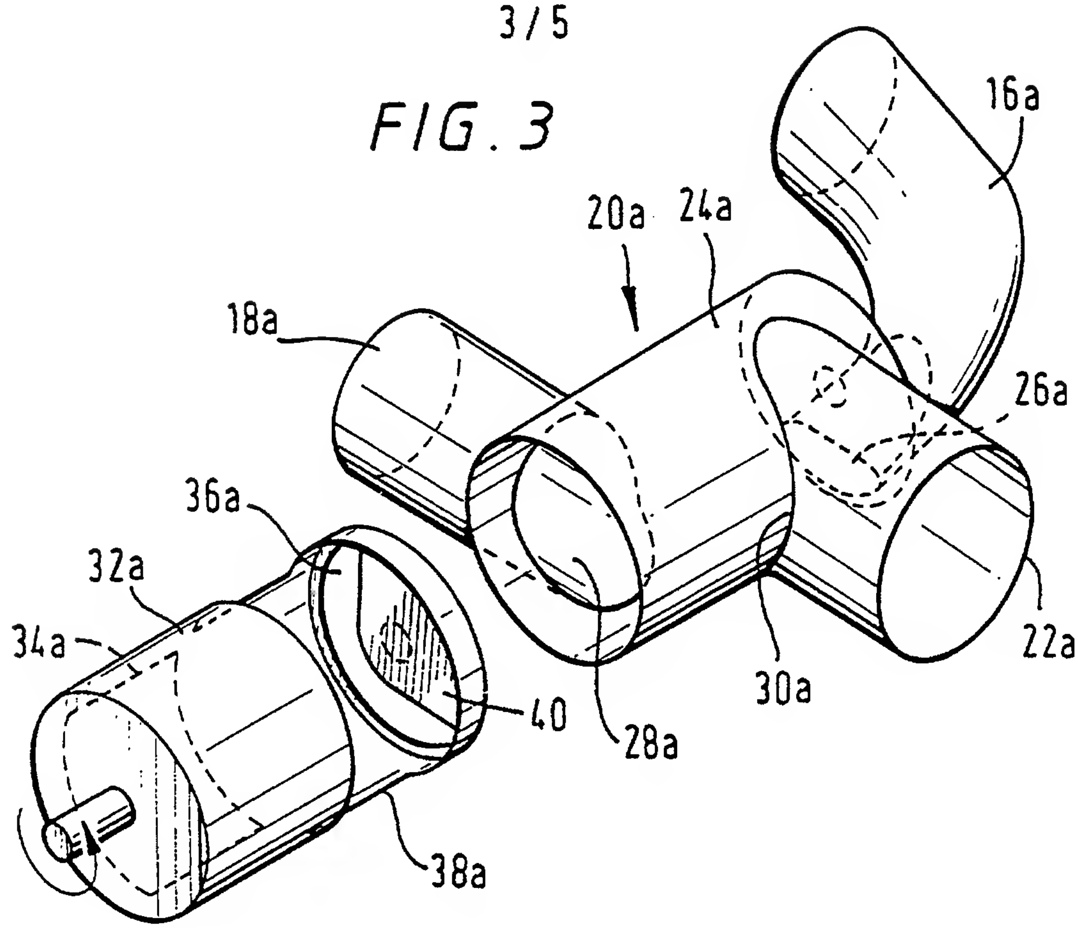
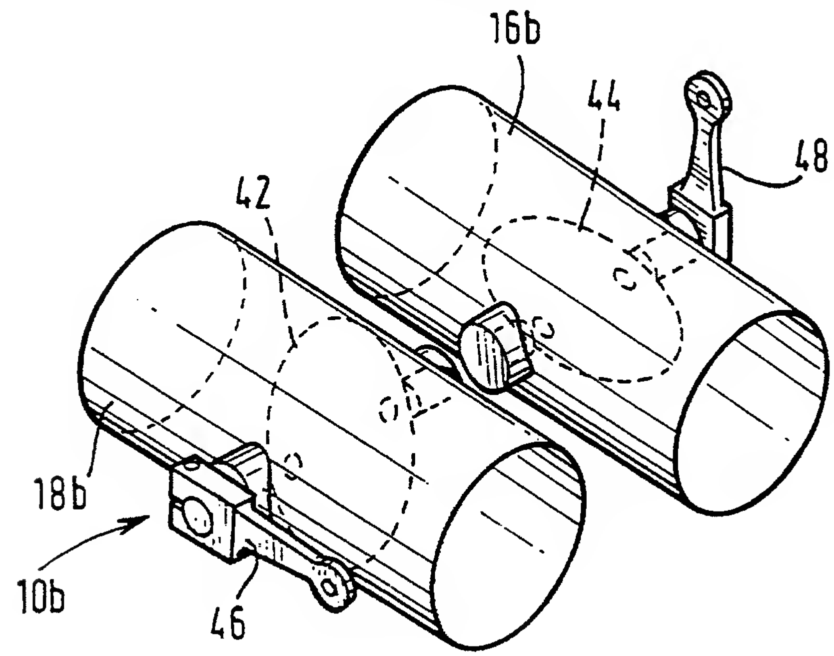

16a
20a
24a
18a
26a
36a
32a
34a
40
22a
30a
28a
38a

FIG. 4


16b
44
48
42
18b
10b
46

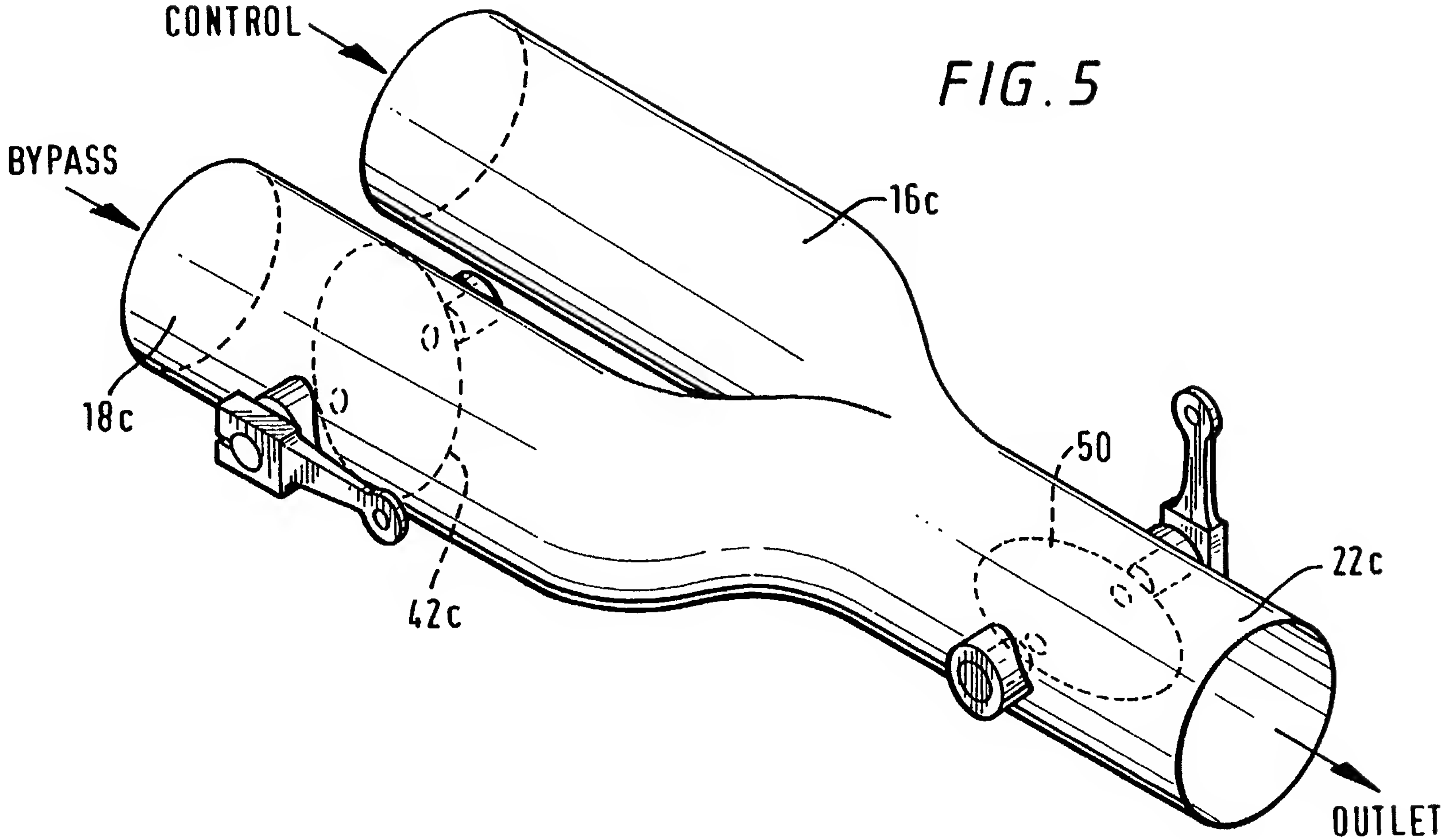
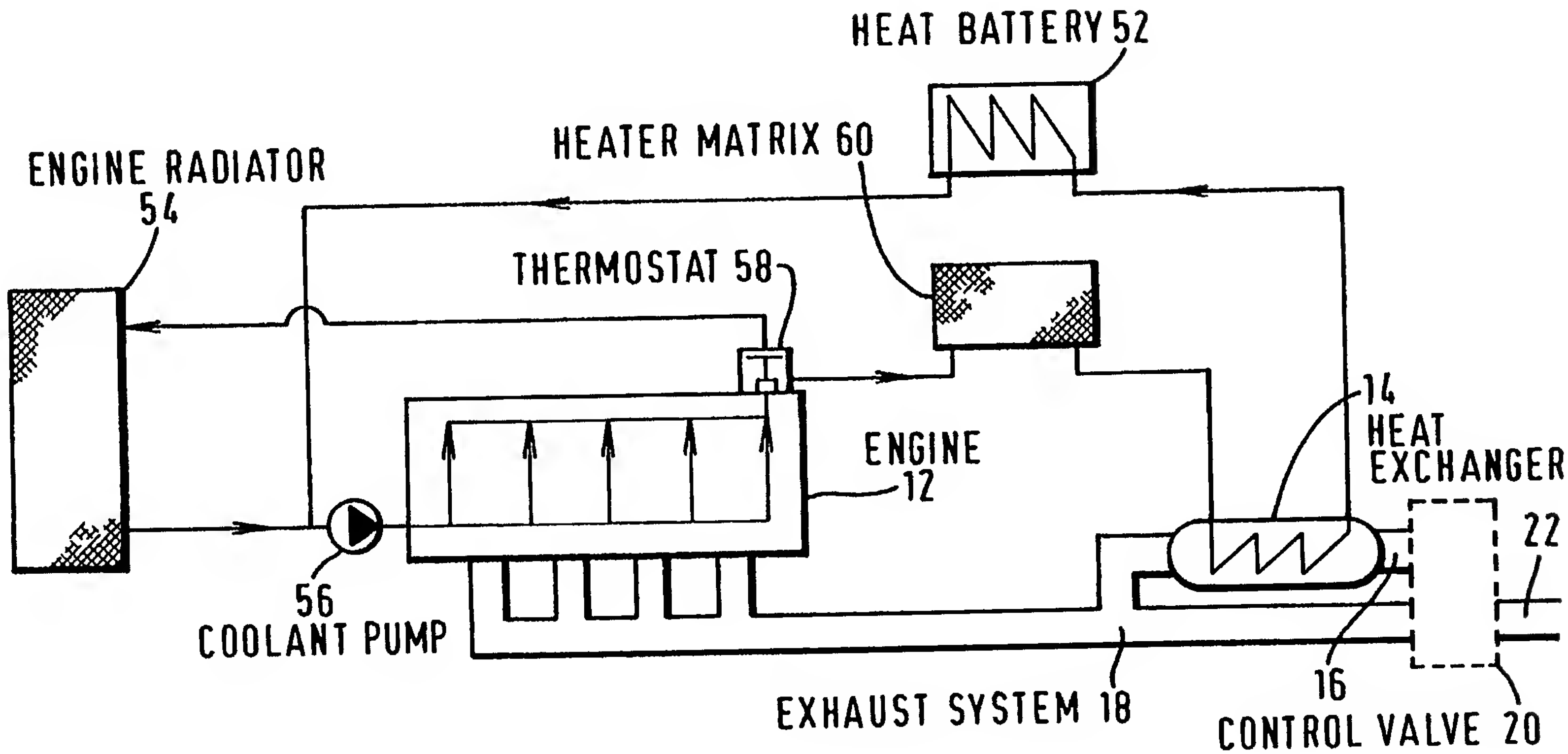


FIG. 5

FIG. 6


HEAT BATTERY 52
HEATER MATRIX 60
ENGINE RADIATOR
54
THERMOSTAT 58
ENGINE
12
14
HEAT
EXCHANGER
22
56
COOLANT PUMP
EXHAUST SYSTEM 18
16
CONTROL VALVE 20

CONTROL VALVE FOR HEAT EXCHANGERS IN INTERNAL COMBUSTION ENGINES

This invention relates to a control valve for controlling the flow of fluid through a pair of fluid transfer ducts. The invention is particularly, although not exclusively, useful for controlling the flow of exhaust gasses from an internal combustion engine through a heat exchanger disposed in one of a pair of exhaust ducts by progressively opening or closing the ducts until the flow through the two ducts are as required and/or the pressure upstream of the valve is at a requisite level.

In some motor vehicles and particularly diesel powered motor vehicles which have sizeable interior cabins, the cabin temperature can take some considerable time to be raised to a level which in some climatic conditions is agreeable to the occupants, particularly over short journeys. It is known to use electric and fuel burning pre-heaters to pre-heat the engine coolant and vehicle cabin and to use heat batteries which are recharged by operation of the vehicle during running. Heat batteries pre-heat a vehicle cabin by releasing the stored energy but in order for such waste heat devices to be effective, the journey time needs to be long enough to recharge the heat battery to a satisfactory level for re-use.

The present invention seeks to provide the control of the distribution of a fluid through a pair of passageways and, more specifically to improve the heating system of a motor vehicle so as to reduce the time in which the engine and cabin temperature are brought up to an operational level and to maintain engine and cabin temperature at a requisite level during periods of light engine load.

One aspect of the invention provides a method of controlling the flow of a fluid through a pair of fluid ducts which method comprises progressively closing at least partially one of the ducts while the other of the ducts remains at least partially open in order to divert a proportion or all of the fluid through the other of the ducts or until the pressure of the fluid upstream of the valve is at a required level.

Another aspect of the invention provides a method of controlling the flow of exhaust gasses in an internal combustion engine in order to allow the engine to be warmed up more quickly in which a heat exchanger is provided in a control duct of the engine exhaust system and a bypass duct is provided through which exhaust gasses can flow without passing through the heat exchanger, which method comprises progressively closing at least partially said bypass duct to divert at least a proportion of the exhaust gasses through said heat exchanger in the control duct thereby causing the engine coolant to extract heat from the heat exchanger.

Yet another aspect of the invention provides method of operating a control valve for controlling fluid flow in a pair of fluid passageways by progressively closing both of the passageways in such a way that one of the passageways is closed before the other.

Yet another aspect of the invention provides an exhaust system for an internal combustion engine which system comprises a heat exchanger provided in a duct of the system, a bypass duct through which, in use, exhaust gasses can flow without passing through the heat exchanger and a control valve to control the flow distribution of exhaust gasses through both ducts and/or to alter the back pressure in the system upstream of said control valve.

According to a feature of this aspect of the invention the heater exchanger duct and the bypass duct may be controlled by said control valve in parallel.

According to another feature of this aspect of the invention the ducts may be controlled by said valve simultaneously.

Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a schematic view of an exhaust system of an internal combustion engine including a heat exchanger and a control valve according to the invention;

Figure 2 is a schematic perspective view of one type of rotary control valve suitable for use in the system;

Figure 3 is a schematic perspective view of a second type of rotary control valve suitable for use in the system;

Figure 4 is a schematic perspective view of a butterfly type control valve suitable for use with the system;

Figure 5 is a further schematic perspective view of another butterfly type control valve; and

Figure 6 is a schematic view of an exhaust system and engine coolant circuit of an internal combustion engine including a heat exchanger, a heat battery and a control valve according to the invention.

Referring to the drawings, Figure 1 shows an exhaust system 10 for an internal combustion engine 12 in which a heat exchanger 14 is included such that heat may be extracted from the exhaust gasses to raise the temperature of the engine coolant. The heat exchanger 14 is disposed in a control duct 16 which is in substantially parallel axial relationship with respect to a length of a main bypass duct 18. A control valve 20 is connected across the control duct 16 and the bypass duct 18 to control the flow distribution of exhaust gasses therethrough whereafter the exhaust gasses leave the system through an exit duct 22.

In a first embodiment of a control valve according to the invention, control valve 20 shown in Figure 2 comprises a cylindrical valve chamber 24 which is connected transversely across the control duct 16 and the bypass duct 18 and, at a diametrically

opposed location relative to ducts 16 and 18 is connected transversely across the exit duct 22. The control and bypass ducts communicate with the valve chamber 24 by means of inlet ports 26 and 28 respectively. An outlet port 30 communicates the valve chamber 24 with the exit duct 22.

In order to control flow of fluid through the valve a rotatable valve body 32 is a sliding fit within the valve body 24. The valve body is hollow and includes spaced openings 34, 36 and 38 which are arranged so as to communicate with the bypass duct 18 the control duct 16 and the outlet duct 22 respectively. Opening 38 has a greater circumferential extent than the neighbouring opening 36. The openings are arranged such that when the opening 34 is fully aligned with the inlet port 18 then so too is the opening 38 aligned with the outlet duct 22 so that the flow of exhaust gasses pass through the valve to the outlet duct 22 with minimum flow restriction. The opening 34 does not necessarily communicate the inlet port 28 of the bypass duct with the outlet port 30 due to the relative sizing of the apertures 34 and 38. In some operating conditions, for example when it is required to extract heat from the engine quickly at start-up, the valve body is rotated to a position in which the bypass duct 18 is at least partially closed while the opening 36 fully communicates the control duct 16 with the outlet duct 22. This distributes the exhaust gas flow in favour of the control duct. The valve may then be controlled so that the restriction created in the bypass duct is relieved by reverse rotation of the valve body 32 relative to the valve chamber 24 so that the bypass duct again fully communicates with the exhaust duct to reduce the engine load. Conversely, continued rotation of the valve body after the bypass duct 18 has been fully closed will progressively close the control duct 16 and, in some situations, where it is required to increase the engine load and hence the heat output through the heat exchanger to some considerable degree the valve body can be caused to occupy a position in which the bypass duct is fully closed and control duct is largely closed. When the valve is set in this position, engine load is increased to increase the heat output of the engine so that heat transferred to the engine coolant by the engine and heat exchanger is increased. Thereafter, pressure in the system can be relieved by reverse rotation of the valve body progressively to open the control duct

and thereafter the bypass duct. It will be appreciated that the progressive closure of the control duct following sequentially from the closure of the bypass duct is effected as a continuation of the operation of the valve.

Referring now to Figure 3 of the drawings a further rotary valve arrangement 20a is illustrated and like parts to those of the construction shown in Figure 2 are designated like reference numerals with the addition of the suffix "a". In this embodiment the cylindrical valve chamber is not connected transversely across parallel control and bypass ducts but instead the control duct 16a is ported to the valve cylinder body axially. The relative positions of the bypass duct 18a and the outlet duct 22a are, however, generally as in the previous embodiment. In order to control flow of exhaust gasses through the valve a rotary valve body 32a is a sliding fit within the cylindrical valve chamber 24a. The valve body 32a includes a window aperture 34a for controlling the flow of exhaust gasses through the valve from the bypass duct 18a, a further window opening 38a for controlling egress of exhaust gasses from the valve through the outlet duct 22a and an axial end port 36a which comprises a circumferentially extending opening formed in an end plate 40 which control the opening or closure of the port 26a.

Thus, as in the previous embodiment the porting and corresponding apertures of the rotary valve body are arranged such that the bypass duct 18a can progressively be closed while the control duct remains open until such time as, if desired, the bypass duct 18a can be completely closed while the control duct remains open. Thereafter by continuing rotation of the rotary element in the same sense the control duct 16a can also progressively be closed until the bypass duct is closed and the control duct largely closed.

Figure 4 of the drawings shows a butterfly valve arrangement 10b for the bypass duct 18b and the control duct 16b. Like parts to those of previous embodiments are designated like reference numerals with the addition of suffix "b". In valve 10b a butterfly vane 42 is rotatably mounted in the bypass duct 18b to control the flow of

exhaust gasses therethrough and a similar butterfly vane 44 is rotatably mounted in the control duct 16b also to control the flow of exhaust gasses therethrough. The valve vanes are operated by means of control levers 46 and 48, respectively, which themselves are linked to suitable actuating means. The vanes may be operated independently or may be connected to operate in tandem. In either case vane 42 is set at a different axial inclination to that of vane 44. Thus, as in the previous embodiments, vane 42 can be rotated progressively to close the bypass duct 18b while the control duct remains open and, through continued operation of the valve, vane 44 can be rotated progressively partially to close the control duct. Further operation of the valve is such that opening of the control duct would be initiated first followed by progressive opening of the bypass duct.

Figure 5 of the drawings shows a butterfly valve arrangement similar in some respects to that of Figure 4 except that in this embodiment there is a valve vane 42c in the bypass duct 18c and a valve vane 50 in the outlet duct 22c but none in the control duct 16c. In this arrangement, in order to alter the flow distribution of the exhaust gasses, instead of closing the control duct, the outlet duct valve vane is moved to a partially closed position after closing the bypass valve. Thus, back pressure in the exhaust system can be increased but full back pressure is felt only by valve 50 in the outlet port so that leakage is reduced over other embodiments. Other valve types may be adopted in a similar configuration. Moreover, in the embodiment shown in Figure 5, the valving could be arranged so that the exhaust flow was in the opposite direction. Hence, valve 50 would be upstream of valve 42c in the bypass duct.

Figure 6 shows an engine exhaust system, according to the invention incorporated as part of a fluid circuit in a motor vehicle fitted with a heat battery. The heat battery 52 is heated by fluid from a heat exchanger 14 disposed in a control duct 16 upstream of a control valve 20. The outlet from the heat battery is linked to the engine coolant inlet from the engine coolant pump 56. Coolant is pumped around the circuit by a coolant pump 56 so that after leaving the engine 12 coolant passes back through the

radiator 54 and/or heat exchanger via a thermostat 58 and a heater matrix 60 and is returned for reheating to the heat exchanger 14.

In an alternative engine exhaust system in which any one of the embodiments of valving described above is incorporated, it is envisaged that the valving could be positioned upstream, in terms of gas flow, of the heat exchanger and bypass duct. In such an arrangement the valving would still control the exhaust gas back pressure experienced by the engine and the flow distribution through the control and bypass ducts but would not control the pressure in either the control or bypass ducts. The main advantage of such a configuration is that it may allow installation of a system according to the invention to be fitted where the system first described could not be fitted.

The valves according to the invention can be controlled in a variety of ways. For example simple thermostatic and pressure operated actuators may be utilised acting directly under the influence of operating parameters such as heat exchanger coolant outlet temperature and back pressure up stream of the valve. A wax type thermostat and a diaphragm type actuator responding to back pressure would be typical actuators for this simple system. An alternative to a simple control system is one brought under engine management control. Such a system would use sensors attached to an engine management system to monitor the temperature of the coolant, the back pressure and potentially various other relevant parameters. Depending upon engine operating conditions and heat demand the necessary valve position to optimise performance would be selected. Valve position could be adjusted using either electro mechanical, vacuum, hydraulic or compressed air actuators dependent upon vehicle type and the available power sources.

CLAIMS

1. A method of controlling the flow of exhaust gasses in an internal combustion engine in order to allow the engine to be warmed up more quickly in which a heat exchanger is provided in a control duct of the engine exhaust system and a bypass duct is provided through which exhaust gasses can flow without passing through the heat exchanger, which method comprises progressively closing at least partially said bypass duct to divert at least a proportion of the exhaust gasses through said heat exchanger in the control duct thereby causing the engine coolant to extract heat from the heat exchanger.

2. A method of operating a control valve for controlling fluid flow in a pair of fluid passageways by progressively closing both of the passageways in such a way that one of the passageways is closed before the other.

3. An exhaust system for an internal combustion engine which system comprises a heat exchanger provided in a duct of the system, a bypass duct through which, in use, exhaust gasses can flow without passing through the heat exchanger and a control valve means to control the flow distribution of exhaust gasses through both ducts and/or to alter the back pressure in the system upstream of said control valve.

4. An exhaust system according to claim 3 wherein the heater exchanger duct and the bypass duct are controlled by said control valve means in parallel.

5. An exhaust system according to claim 3 or claim 4 wherein the ducts are controlled by said control valve means simultaneously.

6. An exhaust system according to any of claims 3 to 5 wherein the control valve means is upstream of the heat exchanger.

7. An exhaust system according to any of claims 3 to 5 wherein the control valve means is downstream of the heat exchanger.

The Patent Office

10

Application No: GB 9510080.6
Claims searched: 1, 3-7

Examiner: Paul Makin
Date of search: 19 August 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): F4U (UA) ; F4S (S42P)

Int Cl (Ed.6): F01P 3/00, 11/00, 11/20 ; F01N 5/00, 5/02 ; F28F 27/02

Other: Online : WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	US 4685430 (NGY) See particularly Figure 4.	1,3,4,5,6, 7.

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
		E	Patent document published on or after, but with priority date earlier than, the filing date of this application.
&	Member of the same patent family		